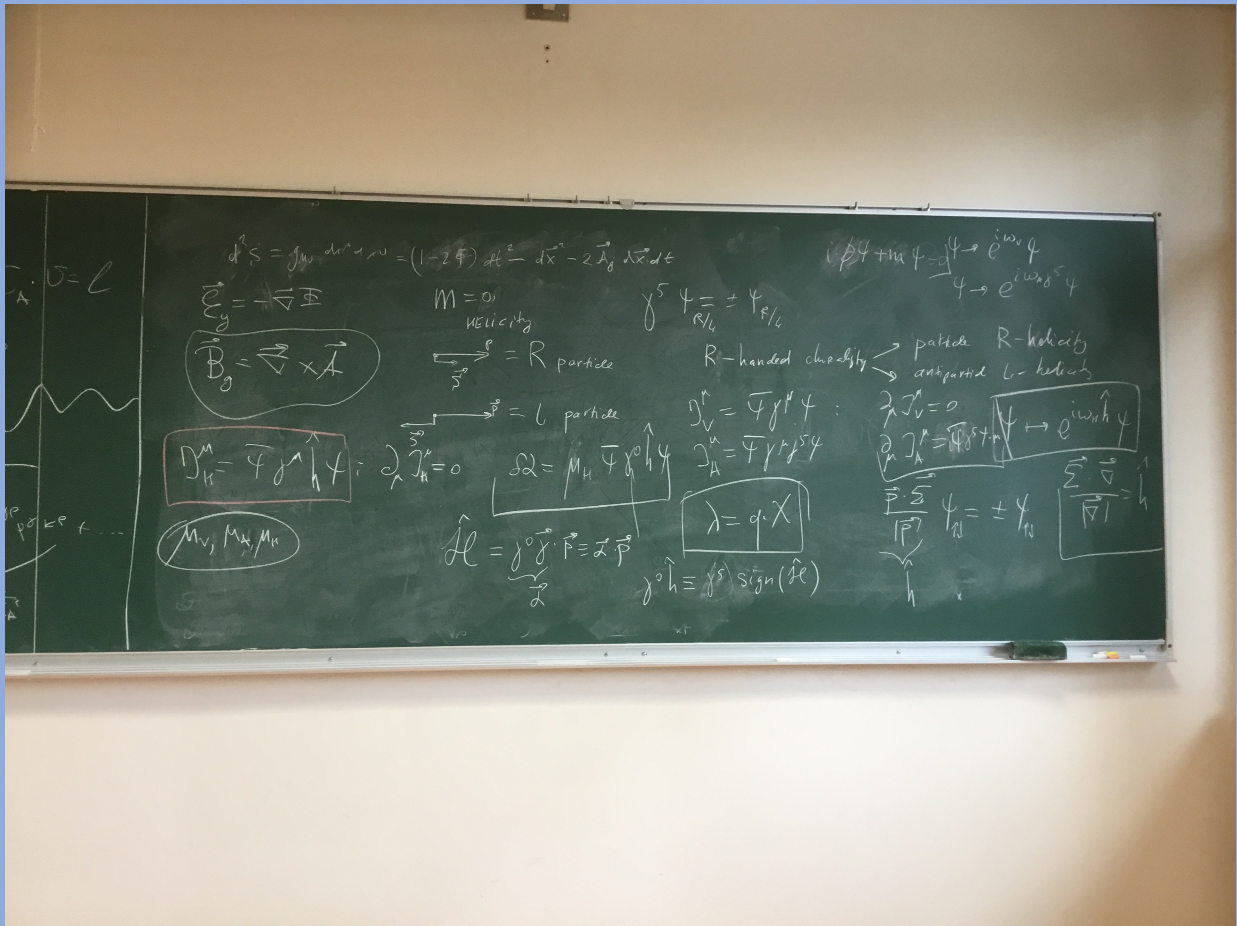


Department of Mathematics and Physics “Ennio De Giorgi”, University of Salento, Lecce

PhD Programme

Physics and Nanosciences

Planned Courses

A.A. 2020/2021

Coordinator: Prof. Claudio Corianò

The courses are divided into shared courses and non-shared ones.

The **shared courses** are jointly offered by **Bari, Lecce and Naples**.
They represent a first step for creating a network between the doctoral schools of the three universities.

Non-shared courses, are held by researchers of UniSalento or by researchers of the CNR, IIT, INFN and INAF Institutes and the **shared ones**.

A common website is under construction.

Shared Courses

jointly offered by Bari, Lecce and Naples

I. Particle Detectors–Trigger/DAQ

Module 1	Particle Detectors
Lecturer	Margherita Primavera (INFN Lecce)
Planned hour	22
Planned schedule	Spring 2021
Prerequisites	Charged particles interactions with matter
Description	Generalities on gaseous detectors. Ionization and transport phenomena in gases. Amplification in gases. Gaseous detectors: ionization chambers, proportional counters, MultiWire Proportional Chambers, Drift chambers, TPC, Geiger counters, streamer tubes, Resistive Plate Counters. Calorimetry. Electromagnetic and hadronic calorimeters. Calorimeter calibration and monitoring. Cherenkov detectors: DISC, RICH, DIRC. Transition radiation detectors. Micropattern detectors, dual readout calorimeters.

Module 2	Photodetection
Lecturer	Elisabetta Bissaldi (Politecnico di Bari)
Planned hour	16
Planned schedule	Apr/Mai/June 2021 (TBD) 1 lecture per week two hours each
Prerequisites	Experimental particle physics background
Description	This course aims to provide the student with advanced knowledge of radiation measurements and detection techniques, from classic scintillation detectors to Silicon Photomultiplier devices. It requires an elementary background in radiation measurements, radiation matter interactions and basic electronics. The program includes Photon-matter interactions; Organic and Inorganic scintillators; Optical coupling; Solid-state photodetectors; SiPM technologies, properties and Applications.Part of the course will be devoted to laboratory sessions.

Module 3	Trigger and DAQ for Particle Physics
Lecturer	Massimo Della Pietra (Univ. Federico II NAPOLI)
Planned hour	10
Planned schedule	Spring 2021
Prerequisites	Experimental particle physics background
Description	Introduction to trigger and data acquisition system for experimental physics. Basic elements and definitions: trigger latency and trigger rate. Connection between trigger e data acquisition: dead time and busy status. Multilevel trigger systems, trigger for High Energy Physics at colliders. Integration of Trigger - DAQ and related systems Event building, Run Control, Online data quality. Description of most relevant trigger system for collider HEP: the trigger system of the LHC experiments. Trigger systems for fixed target experiments and for test-beam setup. Triggerless DAQ systems for particle and astroparticle physics. The impact of the trigger system efficiency on a physical measurement.

II. Signals formation and treatment in particle detectors

Module 1	Signals formation
Lecturer	Marcello Abbrescia (uniba)
Planned hours	10
Planned schedule	5 lectures of 2 hours each in April-May 2021
Prerequisites	Basic notions of electromagnetism and of particle detector physics
Description	- Electrostatics-Principles-Reciprocity-Induced currents-Induced voltages-Ramo-Shockley theorem-Mean value theorem- Capacitance matrix-Equivalent circuits; - Signals in: -Ionization chambers-Liquid argon calorimeters-Diamond detectors-Silicon detectors-GEMs (Gas Electron Multiplier) -Micromegas (Micromesh gas detector) -APDs (Avalanche Photo Diodes)-LGADs (Low Gain Avalanche Diodes)- SiPMs(Silicon Photo Multipliers) -Strip detectors-Pixel detectors- Wire Chambers -Liquid Argon TPCs.

Module 2	Signals treatment
Lecturer	Alberto Aloisio (unina)
Planned hours	10
Planned schedule	
Prerequisites	
Description	Sistemi di schermatura e di guardia nella lettura di sensori e rivelatori - Cenni sul noise di componenti attivi e passivi - Uso del simulatore analogico per l'analisi di alcuni casi di studio: rumore di alcune configurazioni base degli amplificatori operazionali, effetto della capacità del rivelatore sul noise gain

III. Di GirolamoMulti-messenger and particle astrophysics of compact objects

Module 1	Compact objects
Lecturer	F. De Paolis (Università del Salento)
Planned hour	6 h
Planned schedule	Spring-fall 2021
Prerequisites	Basic Astrophysics
Description	• Last stages of stellar evolution and formation of the compact objects • Phenomenological properties of neutron stars and pulsars Selected recent topics on the physics of the compact objects
Recommended texts	• Slides of the lecturer and texts suggested during the lectures
Assessment methods	Short essay on one of the topics developed during the lectures

Module 2	Neutrino Oscillations
Lecturer	D. Montanino (Università del Salento)
Planned hour	6-8h
Planned schedule	Spring-fall 2021
Prerequisites	Particle physics
Description	• Introduction to the neutrino masses, mixing and oscillations in vacuum and matter • Phenomenology of neutrino oscillations from terrestrial experiments and astrophysical sources, in particular solar neutrinos
Recommended texts	• Giunti, Kim, “Fundamentals of neutrino Physics and Astrophysics” (Oxford University Press, 2007) • Slides of the lecturer
Assessment methods	Short essay on one of the topics developed during the lectures

Module 3	**Supernova neutrinos**
Lecturer	A. Mirizzi (Università di Bari)
Planned hour	6
Planned schedule	Spring-fall 2021
Prerequisites	Particle physics
Description	• Supernova (SN) explosion mechanism • SN 1987A neutrino observation • Future SN neutrino observations • Neutrino oscillations in dense SN medium
Recommended texts	• G. Raffelt, “Stars as Laboratories for Fundamental Physics” (University of Chicago Press, 1996) • Slides of the lectures
Assessment methods	Short essay on one of the topics developed during the lectures

Module 4	**Gravitation, Relativity and Black Holes**
Lecturer	M. De Laurentis (Università di Napoli)
Planned hour	6-8
Planned schedule	Spring-fall 2021
Prerequisites	analytical mechanics, general relativity
Description	Rotating black holes: Kerr Spacetime and its global properties. Kerr black hole in Boyer-Lindquist coordinates. Zero-mass limit. Kerr-Schild form of the Kerr solution. Ergosphere and Horizon (Infinite redshift surface, Surface gravity, Surface geometry of horizon and ergo surface) Particle and Light Motion in Equatorial Plane. Matter accretion and black hole parameters change. Evolution in the black hole parameter space. Geodesics in Kerr Spacetime: General Case. Light Propagation. Black hole shadow. Generic properties of the rotating black hole shadows (Asymmetry, Flattening etc..). Image of Black Holes with the Event Horizon Telescope.
Recommended texts	Slides of the lectures
Assessment methods	Short essay on one of the topics developed during the lectures

Module 5	Physics and evolution of supermassive Black Holes
Lecturer	M. Paolillo (Università di Napoli)
Planned hour	6-8
Planned schedule	Spring-fall 2021
Prerequisites	Basic classical physics and gravitation. Useful but not required: Module “Gravitation, Relativity and Black Holes”, Introductory astrophysics, Physics of Galaxies
Description	The Discovery of Active Galactic Nuclei; Taxonomy of AGNs; clues to the interpretation: variability, luminosity and efficiency; steps toward unification: Eddington luminosity, Eddington mass and accretion rate; accretion efficiency. The Unified Model; AGN physical scales; broadband emission in AGNs; accretion disk spectrum; X-ray corona and other components. Observational evidence of the Unified Model: Quasar host galaxies; dynamical and reverberation mapping mass measurements; evidence of hidden BLR in Sy2; relativistic distortion in Fe lines; the Milky Way nuclear BH. AGN evolution from multi-wavelength studies of AGN populations optical, X-ray and infrared; luminosity function and number counts; AGN activity and number density evolution; resolving the Cosmic X-ray Background; Soltan argument: how to derive the current Black Hole mass density of the Universe; The link between Supermassive Black Holes and galaxy evolution; Evidences of AGN feedback in galaxies.
Recommended texts	Lecture slides; “Exploring the X-ray Universe”, Seward & Charles,2010)
Assessment methods	Short essay on one of the topics developed during the lectures

Module 6	Gravitational waves and Gamma-Ray Bursts
Lecturer	T. Di Girolamo (Università di Napoli)
Planned hour	6-8
Planned schedule	Spring-fall 2021
Prerequisites	Basic astrophysics and particle physics
Description	Generation of Gravitational Waves (GWs). Binary Black Holes (BBHs) as sources of GWs. Detection of GWs. Observations of GWs from BBHs. Gamma Ray Bursts (GRBs): observations and theoretical models. GRB progenitors. Black holes as central engines and final products of GRBs.
Recommended texts	Shapiro & Teukolsky, “Black Holes, White Dwarfs and Neutron Stars”
Assessment methods	Short essay on one of the topics developed during the lectures

IV. Fundamental interaction: QCD and BSM

Module 1	Perturbative QCD
Lecturer	Francesco Tramontano (NAPOLI)
Planned hour	12
Planned schedule	xxx da decidere quando xxx 2 lectures per week two hours each
Prerequisites	Particle physics background
Description	The lectures introduce to some basic aspects and concepts of perturbative QCD: running coupling and asymptotic freedom, the parton model, infrared divergences and the factorization theorem, parton densities and parton evolution, colour coherence. Applications to e+e-annihilation, deep inelastic lepton-nucleon scattering and hadron-hadron collisions are discussed.

Module 2	Teoria di Regge
Lecturer	Giovanni Chirilli (Regensburg) ref. Claudio Corianò
Credits (planned)	xxx
Planned hour	10
Planned schedule	xxx
Prerequisites	Particle physics background
Description	Regge Theory; High parton density; small x evolution equations and Wilson lines formalism; Background field method; High-energy Operator Product Expansion; High-energy factorization for scattering amplitudes;

Module 3	BSM
Lecturer	Fulvia De Fazio (BARI)
Planned hour	16
Planned schedule	Spring 2020
Prerequisites	Particle physics background
Description	Physics beyond the Standard Model- Reasons to go beyond the Standard Model- Models based on extended gauge groups- Models introducing extra dimensions- Aspects of supersymmetry- Extension of the effective hamiltonians in New Physics Models

V. Artificial Intelligence and Machine learning

Module 1	Machine Learning: basics and applications
Lecturer	Giorgio De Nunzio & Giuseppe Palma (UniSalento)
Planned hours	10
Planned schedule	Five two-hour lectures
Prerequisites	
Description	- ML taxonomy: supervised, reinforcement, unsupervised; - Regression: linear regression, GLM; - Classification: scores (confusion matrix and related measures; ROC curve; calibration; cross entropy, Brier score), class imbalance; - Bias-Variance tradeoff: underfitting, overfitting. - Perceptrons and Shallow Feed-Forward Neural Networks - Regression and Classification in Matlab+Toolboxes - Applications of regression and classification: case studies in Physics and Medicine with synthetic and public access data (Matlab) - Applications of regression and classification: case studies in Physics and Medicine with synthetic and public access data (Matlab)

Module 2	Approximate reasoning and evolutionary computation
Lecturer	Giovanni Acampora, Autilia Vitiello & Ferdinando Di Martino (Napoli)
Planned hours	10
Planned schedule	Four lectures
Prerequisites	
Description	Introduction (1 hour) Prof. Giovanni Acampora Approximate reasoning (5 hours) Prof. Ferdinando Di Martino Lecture 1 Fuzzy sets and fuzzy relations. Fuzzy operators: t-norm, s-norm, residuum. Fuzzy membership functions and fuzzy numbers. The extension principle. Fuzzy partitions and Linguistic variables. Lecture 2 Fuzzy inference systems: fuzzy rule set inference systems. Mamdani fuzzy inference model. Tagaki-Sugeno- Fuzzy inference model. Type2 fuzzy sets: intervsl type2 fuzzy sets. Interval type2 fuzzy systems. Evolutionary computation (4 hours) Prof. Autilia Vitiello Lecture 1: Introduction to the Evolutionary Computation and its motivations. The main scheme of an Evolutionary algorithm. Lecture 2 : Different evolutionary algorithms: Genetic Algorithms, Differential Evolution and Particle Swarm Optimization. Design issues for evolutionary algorithms: parameter tuning and performance measures.

Module 3	Causality analysis of time series data
Lecturer	Sebastiano Stramaglia (Bari)
Planned hours	Five two-hour lectures
Planned schedule	
Prerequisites	
Description	Programme Lect 1: Complex Networks. Small world networks: Watts-Strogatz model. Scale free networks: Albert-Barabasi model. Communities in complex networks. Applications. Lect 2: The problem of inference of Complex Networks from multivariate time series data. Time Series. Stationarity. Linear correlations and the power spectrum. Cross-correlation and coherence between time series. Prediction. Applications. Lect 3: Introduction to Information Theory. Shannon's Entropy. Mutual Information. Maximum Entropy methods. Transfer Entropy. Applications. Lect 4: Vector autoregressive models. Granger causality and its relation with transfer entropy. Applications. Lect 5: Decomposition of Granger causality in frequency and time. Higher order dynamical networks. Synergy and redundancy. Applications.

VI. Quantum Information, Quantum Computation and Quantum Imaging

Module 1	Physical Coherence and Correlation Functions
Lecturer	Saverio Pascazio (UniBA)
Planned hours	16
Planned schedule	Eight two-hour lectures between February and July 2021
Prerequisites	Background in quantum theory, technologies and applications
Description	Optical Fluctuations and Coherence. Classical and Quantum theory. The Radiation field. Experimental milestones. Measuring correlation functions. Equilibrium equal-time (spatial) correlation functions Equilibrium equal-position (temporal) correlation functions. Beyond equilibrium. Phase transitions and correlation functions.

Module 2	Introduction to Quantum Computation
Lecturer	Luigi Martina (UniSalento)
Planned hours	16
Planned schedule	Eight two-hour lectures between February and July 2021
Prerequisites	Quantum Mechanics and Statistical Mechanics
Description	Since at least a couple of decades, the Physics of Information and Computation has been a recognized as an autonomous discipline. In fact, the latter fields should be linked to the study of the underlying physical processes, namely of the quantum mechanical universe. But the intrinsic probabilistic character of the quantum measurements and the non-commutative algebra of the observables induce important modifications in the central results of classical information theory, including: quantum parallelism, compression of quantum information, bounds on classical information encoded in quantum systems, bounds on quantum information sent over a noisy quantum channel, efficient quantum algorithms and quantum complexity. The course will touch the above topics.

Module 3	Quantum imaging
Lecturer	Milena D’Angelo (UniBA)
Planned hours	16
Planned schedule	Eight two-hour lectures between June and July 2021
Prerequisites	Background in quantum theory and optics. Attendance of either one of the two above modules is suggested.
Description	From classical to quantum imaging. Klyshko advanced wave model. Ghost imaging and diffraction, from first protocols to recent advances (differential GI, computational GI, compressive GI,..). Single-pixel imaging. Super-resolution: NOON states, and Quantum Fisher information. Sub-shot-noise imaging. Imaging by undetected photons. Imaging through turbulence and scattering media, and imaging around corners. Correlation plenoptic imaging: from principles to applications.

VII. Experimental High-Energy Astroparticle Physics

Module 1	HE and VHE observations from Extragalactic sources
Lecturer	Lorenzo Perrone et al (Lecce)
Planned hours	1-2 CFU
Planned schedule	June-July 2021
Prerequisites	Basic particle physics, astrophysics and detectors
Description	The lectures intend to cover the description of the detection techniques of ultra-high energy cosmic rays (Pierre Auger Observatory, Telescope Array) and the current status of the art (result and perspectives) in the field.
Recommended texts	Review papers and journal papers.
Assessment methods	Lessons, final report, hands-on session

Module 2	HE transients and the multimessenger context
Lecturer	Elisabetta Bissaldi (Politecnico di Bari)
Planned hours	2 CFU (1 CFU = 8 hours)
Planned schedule	May-June 2021
Prerequisites	Basic astrophysics, Detectors
Description	- Transient phenomena in the gamma-ray sky: Gamma-Ray Bursts (GRBs), Soft Gamma Repeaters, Terrestrial Gamma-Ray Flashes; Solar Flares. Temporal and spectral characteristics; - Multi-frequency and Multi-messenger studies; LIGO/Virgo gravitational wave (GW) events and follow-up observations; The case of GRB 170817A / GW 170817; IceCube neutrino events and follow-up observations; The case of TXS 0506+056; Other recent discoveries in the field.
Recommended texts	1. Longair - “High-energy astrophysics” 2. De Angelis & Pimenta - “Introduction to Particle and Astroparticle Physics” 3. Recent Publications
Assessment methods	Lessons, final report

Module 3	Indirect Dark Matter searches
Lecturer	Bari (Loparco)
Planned hours	2 CFU (1 CFU = 8 hours)
Planned schedule	Fall 2021
Prerequisites	Basic particle physics and detectors
Description	1) Dark Matter models 2) Dark matter distribution in galaxies 3) WIMPs as dark matter candidates 4) Indirect dark matter searches with gamma rays and charged particles 5) Searches dark matter from the Sun
Recommended texts	Recent publications, some textbooks, slides from the lecturer
Assessment methods	Final report

Non-shared Courses

held by researchers of UniSalento or by researchers of the CNR, IIT, INFN and INAF Institutes

Table A – Courses to be done by Professors and Researchers of the Department of Mathematics and Physics "*Ennio De Giorgi*", University of Salento, Lecce.

		Referent	Title	CFD (hours)	Indicative Schedule
1	Dr.	CASCIONE Mariafrancesca	***Mechanical forces in cell biology***	2 (10)	September -October 2021
2	Prof.	CORIANO Claudio	***Special topics in theoretical physics***	2 (10)	
3	Dr./Dr.	DE GIORGI Maria Luisa/LORUSSO Antonella	***Electronic Microscopy***	3 (15)	
4	Dr.	DE MATTEIS Valeria	***Nanostructured materials: physico-chemical properties and applications in different fields***	2 (10)	September-October 2021
5	Dr.	DE NUNZIO Giorgio	***Programming "Object oriented" in C ++***	4 (20)	
6	Prof.	DE PAOLIS Francesco	***Astrophysics of collapsed objects***	3 (15)	June 2021
7	Dr.	MORELLO Giovanni	***Physics of inorganic nanocrystals***	3 (15)	May-June 2021
8	Dr.	MORELLO Giovanni	***Polymer nanofibers (NFs) for advanced optical applications***	3 (15)	July-September 2021
9	Dr.	NUCITA Achille	***High Energy X-rays astrophysics and data analysis***	4 (20)	June 2021
10	Prof.	PERRONE Maria Rita	***Aerosol and radiative effects***	3 (15)	
11	Prof.	RINALDI Rosaria	***Molecular and biomolecular electronics***	2 (10)	September-October 2021
12	Dr.	ROMANO Salvatore	***Bioaereosol and its role in the spread of pandemics***	3 (15)	
13	Prof.	STRAFELLA Francesco	***Image Analysis***	6 (30)	October-November 2021
14	Prof.	VENTURA Andrea	***Hadron Collider Physics***	3 (15)	

Table B – Courses to be done by Professors and Researchers of other research institutions.

		Referent	Title	CFD (hours)	Indicative Schedule
1	Dr.	ACCORSI Gianluca CNR-NANOTEC	*Photophysics of artist's pigments*	2 (10)	April-June 2021
2	Dr.	ARIMA Valentina CNR NANOTEC	*Current applications of microfluidic technology*	2 (10)	May-June 2021
3	Dr.	BETTINI Simona DiSTeBA	*Light and nanoparticles: an alliance for LIFE*	2 (10)	July-October 2021
4	Dr.	CIRACÌ Cristian IIT	*Advanced Plasmonics*	2 (10)	September-October 2021
5	Dr.	CUSCUNÀ Massimo CNR-NANOTEC	*Advances in micro- and nano-fabrication: techniques, applications & future prospects*	3 (15)	
6	Dr.	D'AGOSTINO Stefania CNR-NANOTEC & IIT	*Molecular Plasmonics*	2 (10)	May-June 2021
7	Dr.	DE GIORGI Milena CNR-NANOTEC	*Advanced Optical Techniques*	3 (15)	
8	Dr.	ELIA Davide INAF	*Acquisition Techniques for IR imaging and spectroscopy*	3 (15)	June 2021
9	Dr./Dr.	FABIANO Eduardo/DELLA SALA Fabio CNR-IMM & IIT	*Electronic structure methods for ground-state and optical properties*	3 (15)	April-May 2021
10	Dr.	FERRARA Francesco STMicroelectronics & CNR-NANOTEC	*Lab-on-a-Chip diagnostic devices: fabrication and industrial exploitation*	3 (15)	May-June 2021

Table B – Courses to be done by Professors and Researchers of other research institutions.

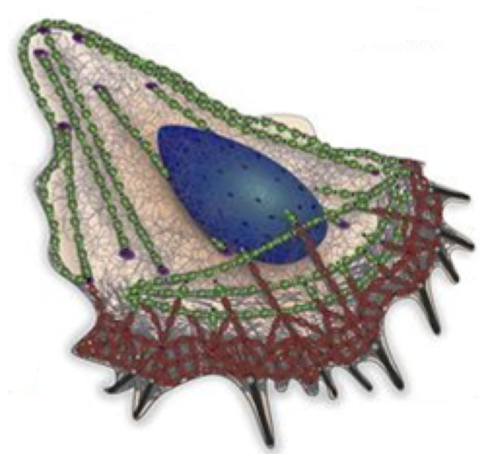
		Referent	Title	CFD (hours)	Indicative Schedule
11	Dr.	GERVASO Francesca CNR-NANOTEC	***Fabrication and characterization techniques of scaffolds for regenerative medicine***	3 (15)	
12	Dr.	GIANCANE Gabriele Dip. Beni Culturali	***Life Through the Looking Glass: chiral symmetry in Nature***	2 (10)	June-October 2021
13	Dr.	GIOTTA Livia DiSTeBA	***Photo-induced phenomena in natural nano-systems***	2 (10)	June-October 2021
14	Dr.	GIOTTA Livia DiSTeBA	***Infrared spectroscopy for functional characterization of (bio)nano-systems***	2 (10)	June-October 2021
15	Dr.	KARPOWICZ Nick CNR-NANOTEC	***Nonlinear optics and numerical photonics***	2 (10)	
16	Dr.	LEPORATTI Stefano CNR-NANOTEC	***Nanomedicine and Techniques of Analysis at Nanoscale***	4 (20)	
17	Dr.	PALMA Giuseppe IBB-CNR (Naples)	***Advanced MATLAB***	4 (20)	
18	Dr.	POLITI Romolo INAF	***Cloud archive and computation. Digital planetology case***	3 (15)	June 2021
19	Dr.	TASSIELLI Gianfranco Dip. Fisica – Università degli Studi di Bari A. Moro	***Lepton Collider Physics***	3 (15)	April-September 2021
20	Dr.	TASSIELLI Gianfranco Dip. Fisica – Università degli Studi di Bari A. Moro	***Particle Physics Laboratory***	4 (20)	April-September 2021

A1. Mechanical forces in cell biology

Dr. CASCIONE Mariafrancesca
mariafrancesca.cascione@unisalento.it

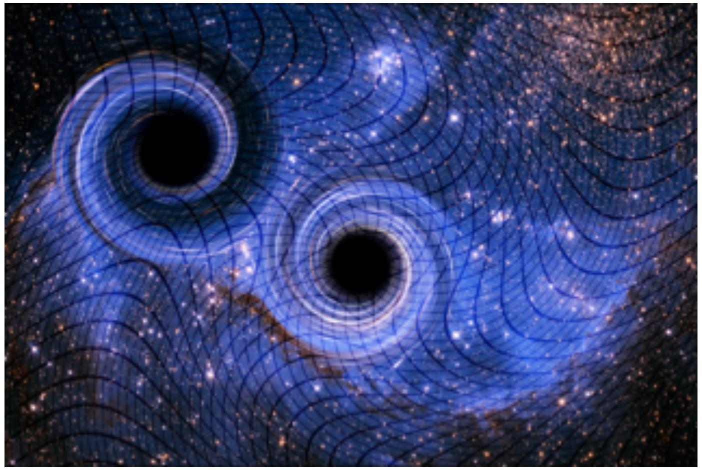
TOPICS:

- Introduction to cell biology (structure, organization, and function of main cellular compartment).
- Why biomechanics is a crucial parameter in physiology and homeostasis?
- Fundaments of mechanics applied to biopolymers.
- Mechanics of cytoskeleton.
- Cell membrane mechanics.
- Force during cellular adhesion and spreading.
- Role of cellular mechanical properties in disease onset and progression.



A2. Special topics in theoretical physics

Prof. CORIANO' Claudio
claudio.coriano@le.infn.it



Quantum Gravity Elements (4 hours)

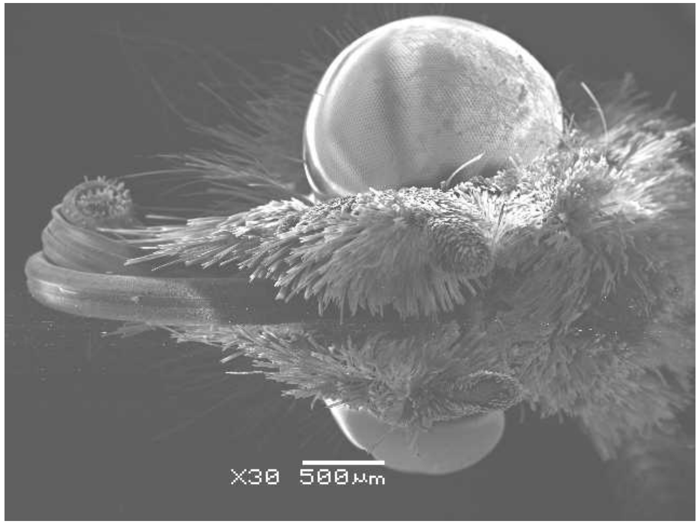
Axion Dark Matter (3 hours)

Standard Cosmological Model (3 hours)

A3. Electronic Microscopy

Dr. DE GIORGI Maria Luisa/Dr. LORUSSO Antonella
marialuisa.degiorgi@unisalento.i/antonella.lorusso@unisalento.it

Introduzione storica.
Microscopio elettronico a scansione (SEM). Componenti fondamentali di un microscopio elettronico (cannone elettronico; sorgenti elettroniche; lenti elettroniche; sistema di deflessione del fascio; sistema da vuoto).
Interazione fascio elettronico primario-campione e generazione di segnali. Elettroni secondari ed elettroni backscatterati. Sistemi di rivelazione e informazioni deducibili.
Generazione di raggi X. Raggi X caratteristici e microanalisi. Rivelatori di raggi X. Analisi qualitativa e quantitativa della composizione elementare (EDX- Energy-dispersive X-ray spectroscopy)
Microscopio elettronico in trasmissione (TEM) e differenze con il microscopio elettronico a scansione. Formazione delle immagini e della figure di diffrazione e loro interpretazione.
Tecniche analitiche associate alla microscopia in trasmissione: spettroscopia EDX ed EELS (Electron energy loss spectroscopy). Mappe chimiche.
Dimostrazione pratica di analisi morfologiche e composizionali con SEM+EDX su campioni degli dottorandi.

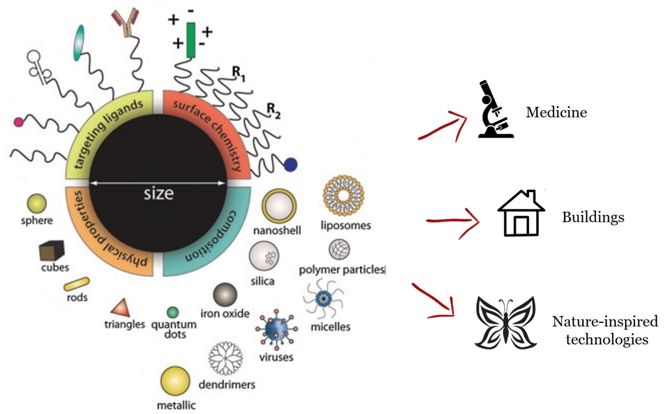


A4. Nanostructured materials: physico-chemical properties and applications in different fields

Dr. DE MATTEIS Valeria
valeria.dematteis@unisalento.it

TOPICS:

- Chemical and physical methods for synthesisof nanostructured materials;
- Physico-chemical properties of inorganic/ organic nanostructured materials andtoxicologyassessment inliving organisms
- Application of nanostructured materials in medicine and diagnostics;
- Integration of nanostructured materials in buildings;
- Nature-inspired nanomaterials: from nature to technological applications.



A5. Programming "Object oriented" in C ++

Dr. DE NUNZIO Giorgio
giorgio.denunzio@unisalento.it

TOPICS:

- Introduzione: installazione dell'ambiente di lavoro, ciclo di produzione di un software, richiami sul linguaggio C (tipi di variabili, puntatori, funzioni, strutture di controllo, ricorsione, allocazione dinamica della memoria…). Differenze di base tra C e C++. Codifica su più file e uso di make.
- File I/O: differenze con il C; file binari e testuali.
- Passaggio di parametri per valore, tramite puntatore, e per riferimento.
- Librerie: object e shared
- Templates. Standard Template Library: std::vector<>, C-string e std::string, std::set, std::map...
- Object-Oriented Programming: struttura di una classe, encapsulation, costruttori/distruttori, overloading, overriding, inheritance…

A6. Astrophysics of collapsed objects

Prof. DE PAOLIS Francesco

francesco.depaolisi@unisalento.it

Program: Formations of the collapsed objects: last stages of stellar evolution. Supernovae. The physics of the gravitational collapse. Neutron star formation and cooling. Pulsars: observational properties and emission mechanisms. Recent discoveries about the braking index. Black holes: Schwarzschild, Reissner-Nordstron and Kerr solutions. Primordial black holes. Geodesics.

Based on the student interests, one CFD can be dedicated to the analysis of a number of topics such as: galactic dynamics (collisional and non-collisional gravitating systems); galaxy and galaxy cluster models; large scale structure formation; gravitational lensing physics.

A7. Physics of inorganic nanocrystals

Dr. MORELLO Giovanni
giovanni.morello@unisalento.it

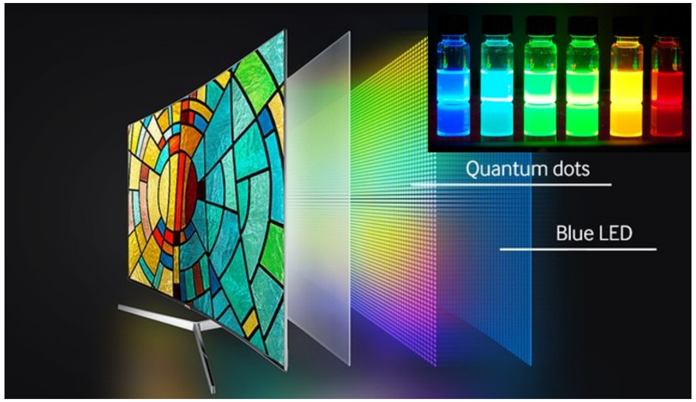
TOPICS:

1. Basic concepts

- Quantum effectsin confined systems
- Excitons and electronic structure in semiconductor NCs
- A case study: CdSe NCs

2. Properties and characterization

- Relaxation paths in NCs
- Optical propertiesvs.the structural and physical parameters
- Advanced characterization methods: Time-resolved spectroscopy (single photon counting and streak camera methods); Single nanoparticle spectroscopy (principles of confocal microscopy, interferometric techniques)



A8. Polymer nanofibers (NFs) for advanced optical applications

Dr. MORELLO Giovanni
giovanni.morello@unisalento.it

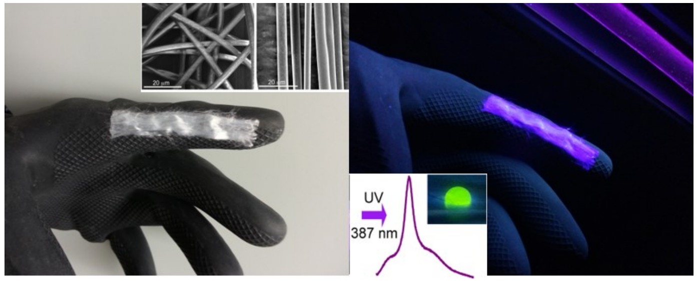
TOPICS:

1. Basic concepts

- Physics of polymers:from filmto fibers

2. Fabrication and properties

- Mechanical and morphological properties of NFs
- Production methods: electrospinning (principles and technical features)
- Optical properties of light emitting NFs and their technological applications.



3. Optical spectroscopy methods

- Optical gain characterization (principles and realization)
- Time-resolved spectroscopy(single photon counting and streak camera experiments)
- Single NF spectroscopy:confocal spectroscopy and single NF waveguiding spectroscopy.

A9. High Energy X-rays astrophysics and data analysis

Dr. NUCITA Achille
achille.nucita@unisalento.it

TOPICS:

- X-ray astrophysics: energetics, time scales and fluxes. Accretion due to gravity and the Eddington limit. Atmospheric absorption. Experimental Tools of High Energy: proportional counters, Gas scintillation proportional counters, Scintillators, Microchannel plates, Microcalorimeters, CCDs
- Emission mechanisms: the radiation field, blackbody radiation, thermal Bremsstrahlung, single Particle Synchrotron Emissivity, thermal Synchrotron, Nonthermal Synchrotron, Compton scattering.
- Application in astrophysics
- Optics in the X-ray and UV regime. Wolter type telescopes.
- Data reduction and calibration. The event event files. Looking at the data, Selecting events of interest and Extracting analysis products. Calibration and Data analysis to extract images and spectra.
- Chandra, XMM-Newton and Swift telescopes: general views. The XMM-Newton telescope SAS system: installation of useful software and data analysis.
- Statistics in low count limit: the statistical underpinning of X-ray data analysis, Probability distributions. Parameter estimation and Confidence bounds
- Introduction to scripting

References:
Fulvio Melia, High energy astrophysics
Mario Vietri, Astrofisica delle alte energie
Arnaud, Handbook of X-ray Astronomy
Attwod, SOFT X-RAYS AND EXTREME ULTRAVIOLET RADIATION

<u>Requirements (for the last part of the course): knowledge of a programming language (C, Fortran, ILD, Python)</u>

A10. Aerosol and radiative effects

Prof. PERRONE Maria Rita
mariarita.perrone@unisalento.it

Nell'ambito del corso di dottorato vengono definite ed illustrate le principali proprietà microfisiche ed ottiche dell'aerosol atmosferico, allo scopo di comprendere e valutare i suoi impatti sulla salute umana, l'ambiente ed i cambiamenti climatici. Vengono altresì trattate le principali tecniche di campionamento "in situ" e con monitoraggio remoto.

Pertanto i principali temi trattati sono:

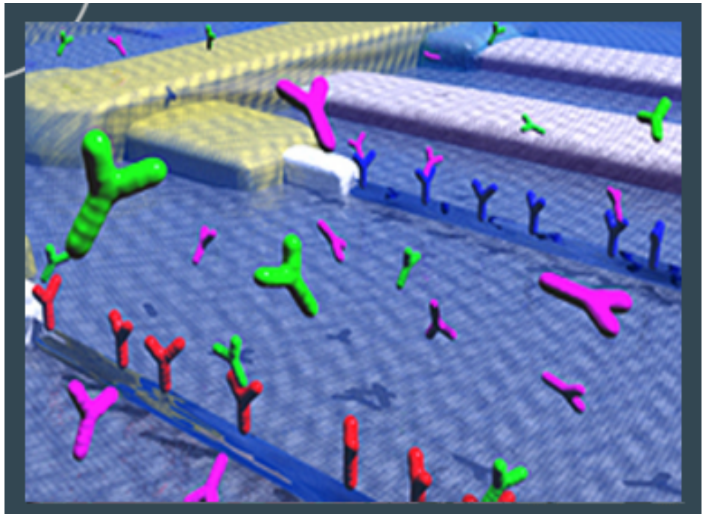
- sorgenti naturali ed antropiche dell'aerosol atmosferico e tecniche di campionamento;
- aerosol primario e secondario, diametro geometrico ed aerodinamico, distribuzioni dimensionali in numero e volume;
- composizione chimica dell'aerosol;
- proprietà ottiche delle particelle di aerosol;
- processi di diffusione ed assorbimento e legge dell'estinzione di Beer Bougeuer Lambert;
- flussi radiativi, variazioni di flusso radiativo attraverso uno strato di particelle, bilancio radiativo terrestre;
- applicazioni del forzante radiativo a casi specifici (e.g. eruzione vulcanica, eclissi di sole).

A11. Molecular and biomolecular electronics

Prof. RINALDI Rosaria
rosaria.rinaldi@unisalento.it

TOPICS:

- Motivation and concepts
- Formal definition of molecular electronics and a little bit of history
- Molectronics nanodevices: fabrication and testing
- The amazing world of bio-inspired computing
- Biomolecular nanodevices: devices based on DNA and proteins
- Molecular Quantum Cellular Automata
- DNA computation
- Conclusions and outlook



Prof. Mark Reed group, Yale University

A12. Bioaereosol and its role in the spread of pandemic

Dr. ROMANO Salvatore
salvatore.romano@unisalento.it

TOPICS:

- Introduzione sul particolato atmosferico: classificazione, sorgenti ed effetti sul clima, sull'ambiente e sulla salute (3 ore)
- La componente biogenica del particolato atmosferico: sorgenti, effetti e possibile ruolo nella diffusione di pandemie (3 ore)
- Tecniche di monitoraggio del particolato atmosferico e della sua componente biogenica (3 ore)-Tecniche di analisi statistica e bioinformatica (3 ore)
- Caratterizzazione delle comunità batteriche e virali in campioni di particolato atmosferico (3 ore)

A13. Image Analysis

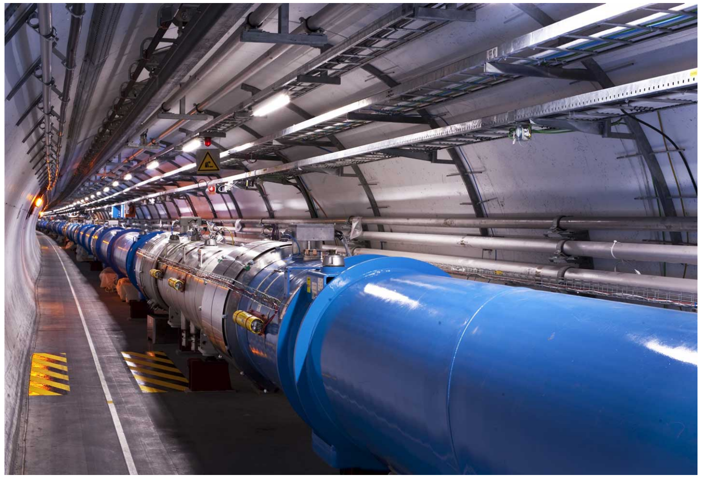
Prof. STRAFELLA Francesco
francesco.strafella@unisalento.it

TOPICS:

- Trasformate di Fourier
- Campionamento e ricostruzione
- Trasformate di wavelet
- Analisi delle componenti principali (PCA)
- Analisi delle componenti indipendenti (ICA)

A14. Hadron Collider Physics

Prof. VENTURA ANDREA
andrea.ventura@unisalento.it



Particle accelerators and main physics quantities related. Elements of magnetic optics. Comparison between fixed target and collider experiments. Comparison between hadronic and electronic colliders.

History and examples of hadronic colliders: ISR, SPS and SppS at CERN, HERA in DESY, RHIC. Modern colliders (Tevatron and LHC) and their main hadronic experiments. Perspectives for future colliders.

CDF and D0 experiments at Tevatron. QCD processes, hadronization, Jet Energy Scale. Processes of production and decay of the Tevatron top quark. Identification of the top quark and mass and cross section measurements at the Tevatron.

The Large Hadron Collider (LHC) and the ATLAS experiment. Inner Detector, Calorimeters and Muon detector systems. Reconstructions of events at ATLAS: from cosmic rays to the “rediscovery” of the W and Z and the discovery of the Higgs boson. Trigger and DAQ system.

Cross sections of processes at the LHC and the Tevatron. Processes with jets. Measurements of masses and cross sections of W and Z at CDF and ATLAS. Top quark production at the LHC and comparison with the Tevatron. Identification of events with top pairs. B-tagging at ATLAS. Production of single tops. Mass measurements of the top at LHC and comparison with Tevatron. Asymmetry and possible FCNC decays of the top.

New Physics searches beyond the Standard Model at the LHC. Exotic decays of the top quark. Supersymmetric models without and with violation of R-parity: selections and techniques of background reduction, inclusive and exclusive searches. Resonance searches at high masses: dileptons, di-jets, diphotons.

B1. Photophysics of artist's pigments

Dr. ACCORSI Gianluca
gianluca.accorsi@nanotec.cnr.it

TOPICS:

- Photophysics basics (light-matter interactions and relative photoinduced processes)
- Application fields
- Role and advantages of photophysics in works of art
- Case studies (Egyptian Blue, Indian Yellow, Manganese Blue, Tyrian purple)
- Experimental techniques (In lab)

B2. Current applications of microfluidic technology

Dr. ARIMA Valentina
valentina.arima@nanotec.cnr.it

TOPICS:

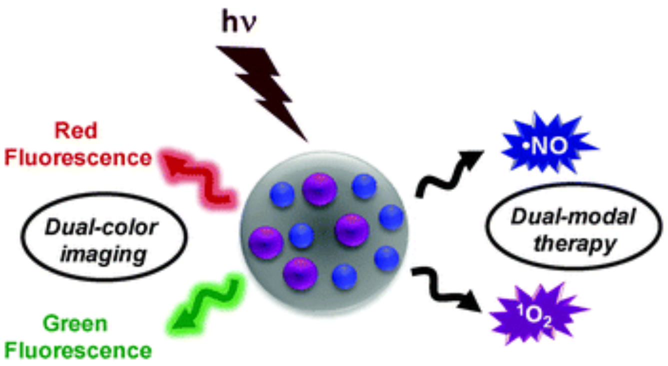
- Fundamentals of microfluidics (2h)
- Microfluidic applications for chemistry (2h)
- Microfluidic applications for biosensing (2h)
- Microfluidics for lab-on-a-chip applications (2h)
- Microfluidics for organ-on-a-chip applications (2h)

B3. Light and nanoparticles: an alliance for LIFE

Dr. BETTINI Simona
simona.bettini@unisalento.it

TOPICS:

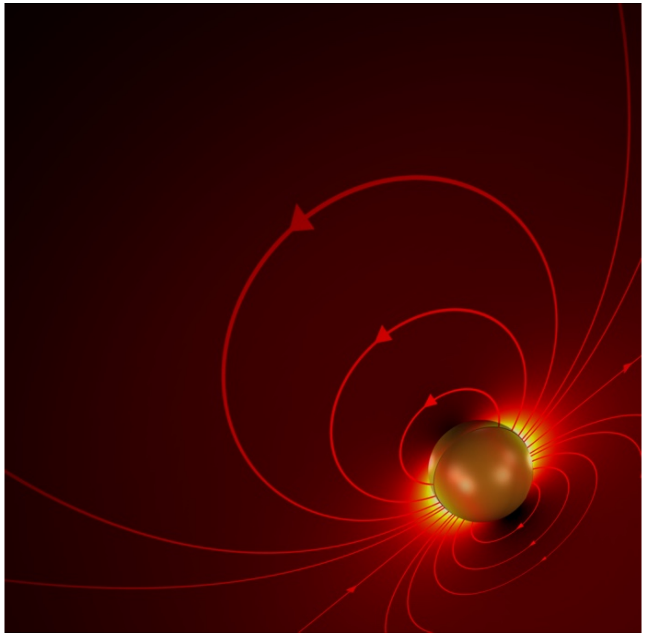
The combined effect of light used as an external trigger in combination to organic/inorganic nanoparticles will be considered from a physical chemical point of view and as a function of the target. Examples about light driven biomedical devices (photodynamic, antibacterial, anticancer therapy) and environmental applications (photocatalysis, water splitting) will be reported and the different approaches will be evaluated in order to highlight the versatility of the approach. The tailoring of nanoparticles features through peculiar mild synthetic procedures (bottom-up) will be also explained. Moreover, one of the lectures aim will be to underline the eco-friendly aspects of the synthesis protocols and of the fate of the proposed systems. Frontiers analytical approaches such as SERS and TERS will be also examined.



B4. Advanced Plasmonics

Dr. CIRACI' Cristian
cristian.ciraci@iit.it

TOPICS:



1. Electromagnetics of metals
- Dielectric function of the free electron gas
- Surface plasmon polaritons

2. Beyond classical electrodynamics
- Spatial dispersion vs nonlocal response
- Thomas-Fermi approximation
- Additional boundary conditions
- Quantum hydrodynamic theory

3. Nonlinear optics
- Nonlinear susceptibility
- Harmonic generation
- Nonlinear plasmonics

4. Numerical methodsfor EM
- Finite-difference method
- Finite-elements method
- Application to EM

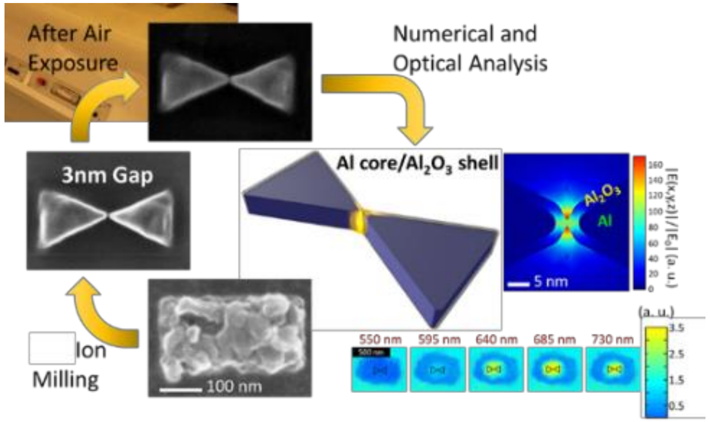
B5. Advances in micro- and nano-fabrication: techniques, applications & future prospects

Dr. CUSCUNA' Massimo
massimo.cuscuna@nanotec.cnr.it

Course Objective:

The objective of the present course is to provide students with a glimpse into the micro- and nano- fabrication techniques along with their applications.

This course consists of two parts: "Micro- and Nano-fabrication techniques" deals with the fabrication of structures at micro and nanoscale, while "Microscopy" concerns the visualization of such small features.



We start with a general overview of micro/nanotechnology, explaining why the properties of materials are so different at the micro/nanoscale compared to the macroscale. The difference between top- down and bottom-up fabrication is explained and the ultimate industrial fabrication process (CMOS) is outlined, including the technological issues related to further scaling according to Moore's Law. We introduce the need of cleanroom environment for what concerns fabrication processes.

Subsequently, advanced material deposition (chemical vapor deposition, atomic layer deposition), etching (wet and dry) and lithography concepts are illustrated; an overview of promising nanopatterning techniques, such as electron and ion beam-based approaches is introduced. We also discuss bottom-up processes such as the chemical growth of nanostructures like carbon nanotubes, silicon nanowires. State-of-the-art applications in the field of electronics, photonics and biosensing exploiting micro- and nano-fabrication techniques are shown.

The second part of the course introduces general microscopy concepts such as magnification, resolution, depth of field and contrast, it is discussed how image formation is achieved in optical and electron microscopy. The latter is mainly addressed because enabling visualization of nanoscale structures.

The lab session involves lithography and scanning electron microscope imaging.

B6. Molecular Plasmonics

Dr. D'AGOSTINO Stefania
stefania.dagostino@iit.it

TOPICS:

1. Metal-Molecule Interactions in the Weak Coupling Regme

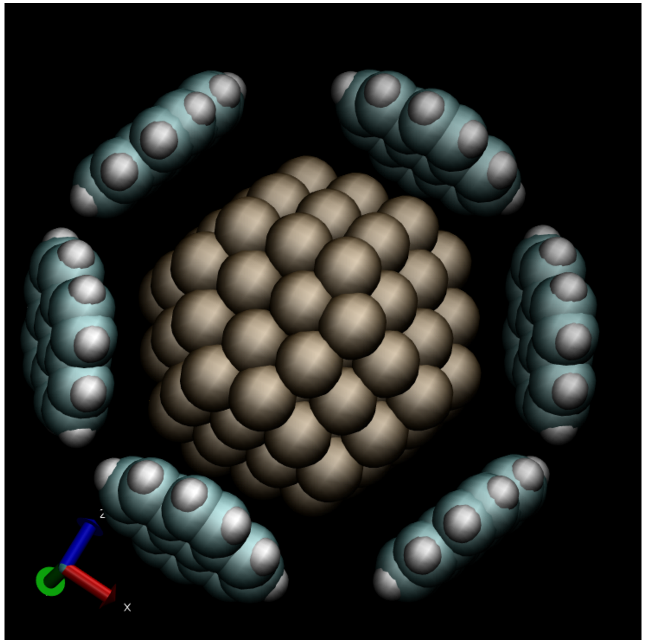
- The Localized Surface Plasmons (LSPs) in Classical Electromagnetism
- Dipole Decay Dynamics Engineering in the Classical Framework

2. Metal-Molecule Interactions in the Strong Coupling Regime

- The Two-Coupled Harmonic Oscillators Paradigm
- The Semi-Classical and Fully Quantum Mechanical Frameworks

3. Metal-Molecule Interactions in the Tunneling Regime

- Basics of Ground-state and Time-Dependent DFT
- DFT-based Approximations for Plasmonic Systems



B7. Advanced Optical Techniques

Dr. DE GIORGI Milena
milena.degiorgi@nanotec.cnr.it

TOPICS:

1. Introduction to standard optical spectroscopy techniques.

2. Optical properties of different materials from semiconductor to hybrid to organic structures.

3. Polarization spectroscopy.

4. Introduction to more advanced optical spectroscopy techniques:

- Confocal microscopy for high spatial resolution experiments;
- Time-resolved spectroscopy for study of carrier dynamics;
- Femtosecond Pump-Probe Transient Absorption Spectroscopy for study;

5. Temporal and spatial coherence.

6. Intensity correlation experiments.

B8. Acquisition Techniques for IR imaging and spectroscopy

Dr. ELIA Davide
davide.elia@inaf.it

TOPICS:

- Propaedeutic topics: Fourier transform, Convolution.
- Observability from the ground as a function of wavelength
- Radiative transfer
- Molecular clouds
- Rotational transitions of molecules: biatomic and polyatomic cases.
- Integrated line intensity maps
- Vibrational transitions of molecules: biatomic and polyatomic cases.
- Rotational spectra in the near infrared
- Raman spectroscopy
- Scheme of a spectrometer
- Illuminating source
- Collimator
- Light dispersion
- Prism
- Interference and diffraction
- Diffraction grating
- Filters
- Fabry-Pérot interferometer
- Generalities on detectors for Infrared
- Pyroelectric detector, thermocouple, bolometer
- Semiconductors, photodiode
- Michelson interferometer, Fourier transform spectroscopy
- Heterodyne
- Acousto-optical detectors
- Infrared imaging: CCD, CMOS, thermal camera
- Bolometer arrays
- False colour images
- Interferometry
- Astronomical interferometers for far infrared and sub-mm
- Polarimetry
- Brewster and Malus laws
- Polarimeters

B9. Electronic structure methods for ground-state and optical properties

Dr. FABIANO Eduardo/DELLA SALA Fabio
eduardo.fabiano@cnr.it/@fabio.dellasala@unisalento.it

TOPICS:

1. Introduction to electronic structure theory
- The electronic problem,
- Spin configurations and spin projection
- Born-Oppenheimer approximation and adiabatic coupling

2. Ab initio methods
- The Hartree-Fock method
- Basis sets and basis set extrapolation
- Roothan and Pople-Nesbet equations
- Post Hartree-Fock correlation methods: MP2 and CI

3. Density functional theory
- Density matrices and electron density, Thomas-Fermi theory
- Basics of ground-state DFT, Hohenberg-Kohn theorems, Levy constrained search, Kohn-Sham method
- Functionals and functional derivatives
- The exchange-correlation functional, XC hole, adiabatic connection
- Exchange-correlation approximations

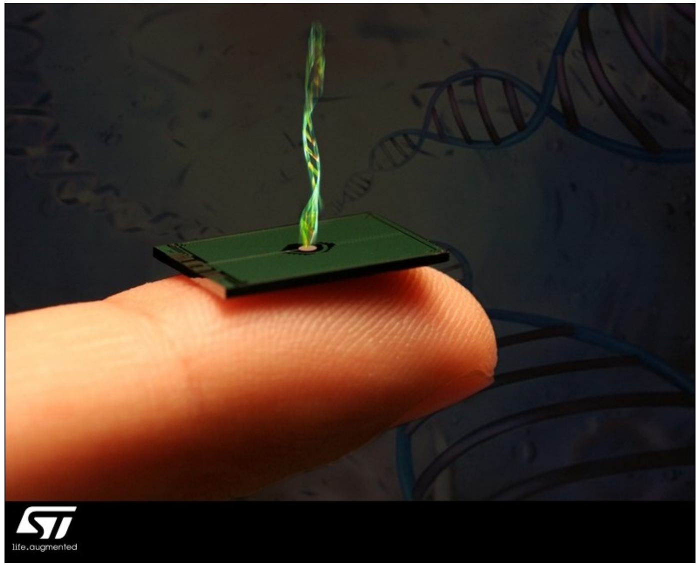
4. Optical properties
- Linear and Non-linear Operators, Volterra Series
- Many-Body Linear Response, Polarizability, Sum rules
- Optical properties of finite and extended systems: Gap and Excitons
- Time-Dependent Density Functional Theory for finite and extended systems
- Many-body and RPA Dielectric functions
- Charge-transfer and Local-fields effects

B10. Lab-on-a-Chip diagnostic devices: fabrication and industrial exploitation

Dr. FERRARA Francesco
francesco.ferrara@st.com

TOPICS:

During lessons, industrial exploitation of medical devices will be described. Part of the course will be spent to introduce basic concept of molecular biology to better understand principal application of lab-on-a-chip and basic techniques for electronic and plastic chip fabrication will be illustrated. Special emphasis will be given to the intellectual properties strategies to protect invention ad how it is possible to use IP in industrial development.



B11. Fabrication and characterization techniques of scaffolds for regenerative medicine

Dr. GERVASO Francesca
francesca.gervaso@nanotec.cnr.it

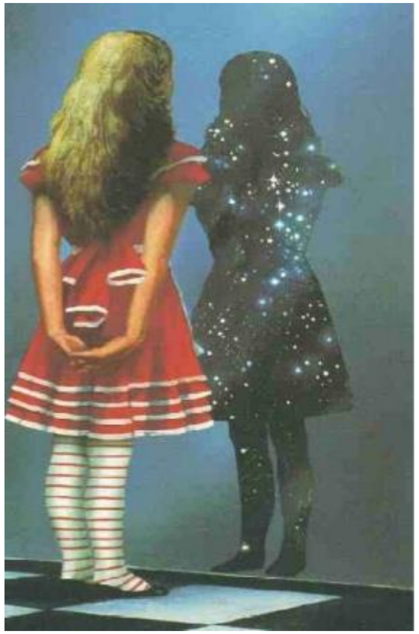
Many biological tissues are unable to regenerate when injured, but only to reproduce a so-called reparative tissue that does not have the same properties as native tissue. One of the fundamental purposes of Tissue Engineering or Regenerative Medicine is to "build" in the laboratory, biological substitutes for damaged or malfunctioning tissues and organs with the final aim of implanting them in patients. The main objective of this course is to provide students with the basic knowledge and skills for understanding the technologies/methodologies currently used for tissue regeneration, including:
- the 'intelligent' use of biomaterials and biopolymers for the development of micro- and nano-structured matrices (i.e. scaffolds) capable of inducing tissue regeneration;
- the use of combined therapies, based on the use of suitable cellular components, molecular regulators and scaffolds;
- the in-depth study of cell-matrix interactions.

- *Tissue Engineering: Introduction*
- *Cell-material interactions: Extra-Cellular Matrix (ECM)*
- *Cell-material interactions: Unit Cell Processes (UCPs)*
- *Scaffold: functions, properties, design variables*
- *Scaffold: fabrication techniques (I)*
- *Scaffold: fabrication techniques (II)*
- *Scaffold: characterization techniques (I)*
- *Scaffold: characterization techniques (II)*
- *Hydrogel: biomedical applications*
- *Surface modifications: plasma treatments for cell culture*
- *Tissue Engineering: cells*
- *Bioreactors*
- *Tissue Engineering: regulators and drug delivery*
- *Biomechanics*
- *Tissue Engineering Application: bone and cartilage regeneration*
- *Tissue Engineering Application: tendon and ligament regeneration*

B12. Life Through the Looking Glass: chiral symmetry in Nature

Dr. GIANCANE Gabriele
gabriele.giancane@unisalento.it

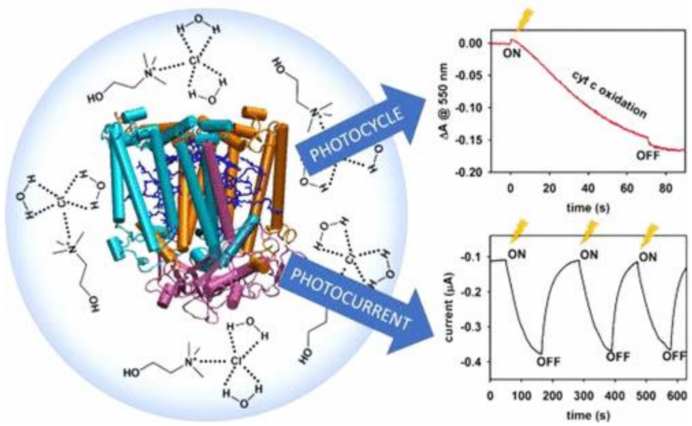
In the first half of the XIX century Louis Pasteur, most known for his important research on the veterinary medicine, detailed the molecular chirality of the tartaric acid by means of optical activity characterizations starting a new direction in chemistry. There is a plethora of chiral molecules in nature, even though is not clear the reason why the Nature almost exclusively uses chiral molecules for building the life. The chemical physical characteristics of the most interesting chiral "objects" and the methods for recognizing them will be examined and discussed. Starting from the understanding of the molecular chiral building blocks (amino acids, nucleotides), the basis for the comprehension of supramolecular chiral systems (proteins, DNA, enzymes) assembly will be attempted.



B13. Photo-induced phenomena in natural nano- systems

Dr. GIOTTA Livia
livia.giotta@unisalento.it

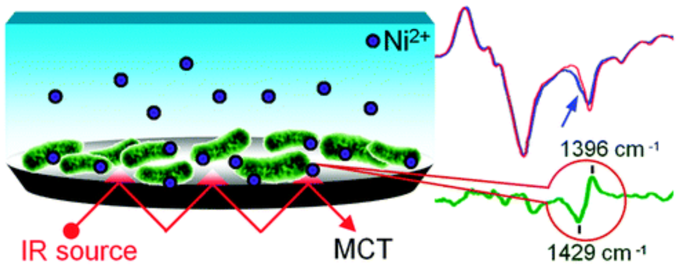
The lectures will provide a short overview on basic concepts of chemical thermodynamics and chemical kinetics relevant to energy conversion processes in biological systems (Gibbs free energy, exergonic and endergonic processes, coupled reactions, order of reaction and molecularity, first- order processes, competitive reactions and kinetic control, Marcus theory). The concepts will be applied to the physico-chemical description of light reactions of bacterial photosynthesis. Some physico-chemical techniques for the investigation of photo-induced electron-transfer processes will be presented. Finally, some applications of natural photosynthetic systems in the field of functional nano-hybrid materials will be introduced and discussed.



B14. Infrared spectroscopy for functional characterization of (bio)nano-systems

Dr. GIOTTA Livia
livia.giotta@unisalento.it

The lectures will provide the fundamentals of vibrational spectroscopy with a focus on the application of mid-infrared absorption spectroscopy for the functional investigation of complex systems. An overview of in situ-techniques based on Attenuated Total Reflectance (ATR) modality will be presented. Practical activities will be proposed, allowing phD students to get familiar with FTIR techniques and to experience the potential of reaction-induced ATR- FTIR difference spectroscopy (light-induced, perfusion-induced, electrochemically-induced) to the investigation of complex systems functioning.



B15. Nonlinear optics and numerical photonics

Dr. KARPOWICZ Nicholas
nicholas.karpowicz@nanotec.cnr.it

TOPICS:

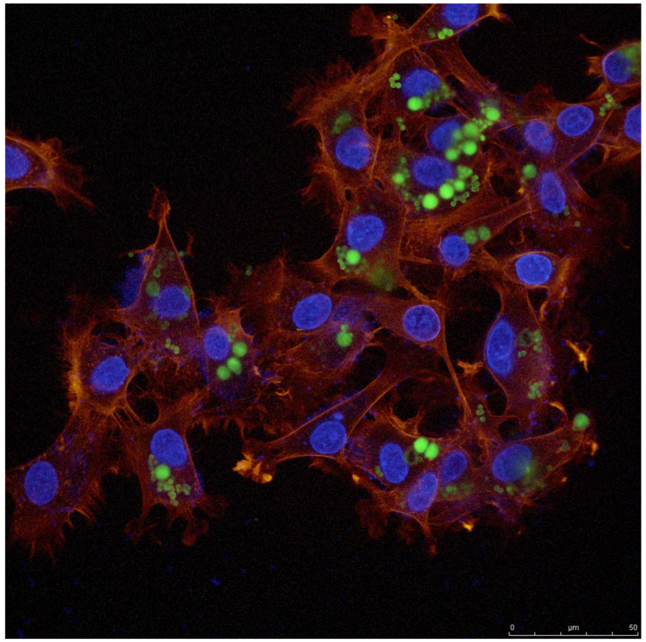
1. Physical origins of the linear and nonlinear optical properties of matter
2. Most widely used 2nd order nonlinear optical processes, phasematching approaches
3. Most widely used 3nd order nonlinear optical processes, phasematching approaches and experimental configurations
4. Understanding and characterizing ultrashort pulses, theory
5. Understanding and characterizing ultrashort pulses, experiment
6. Modelocked oscillators
7. Frequency combs
8. Solving partial differential equations on a grid - introduction
9. Schrödinger-type equation solvers
10. Maxwell's equations
11. Computational plasmonics, optimizing large problems for solution on GPUs with CUDA
12. Local and global optimization techniques

B16. Nanomedicine and Techniques of Analysis at Nanoscale

Dr. LEPORATTI Stefano
stefano.leporatti@nanotec.cnr.it

TOPICS:

- Nanomedicine (4 hours)
- Drug Delivery Systems (DDS) (4 hours)
- Techniques of Bio-funzionalization and Synthesis of Nano e Micro Colloidal Particles (2 hours)
- Atomic Force Microscopy (4 Hours)
- Confocal Microscopy (4 Hours)
- Fluorescence Microscopy (2 hours)



Lessons*: Building G, Second Floor, Room Marie Curie, @ CNR Nanotec, Tuesday and Friday 15.00-17.00 (May-June) or on-line by Microsoft Teams*

Examination*: A seminar on a free Thematic of course (at the end of the course)*

B17. Advanced MATLAB

Dr. PALMA Giuseppe
giuseppe.palma@ibb.cnr.it

- Introduzione: Matlab IDE
- Variabili (tipizzazione, scalari, vettori, matrici, array, allocazione, array di celle, indicizzazione, strutture, tabelle)
- Operatori aritmetico-logici e funzioni built-in
- Ottimizzazione elementare: uso vettoriale di operatori e funzioni
- Programmazione (script, funzioni e struttura degli argomenti, strutture di controllo, scope delle variabili, function handles, tecniche di ottimizzazione del codice, debug, gestione delle eccezioni
- Grafica (figure, assi, plot, superfici, contour plot, istogrammi, immagini, animazioni
- I/O (text files e binary files)
- Numerica (Algoritmi, Soluzione di equazioni, Ottimizzazione, ODE)
- Toolboxes (Parallel Computing Toolbox, Image Processing Toolbox, Partial Differential Equation Toolbox)

B18. Cloud archive and computation. Digital planetology case

Dr. POLITI Romolo
romolo.politi@inaf.it

Nel corso si descriveranno i vari tipi di approccio al calcolo e di archiviazione dei dati, mostrando il percorso che ha portato al *cloud* come risposta alle varie problematiche. Verrà utilizzata l'Astroinformatica e la Planetologia Digitale come applicazione a tale approccio, poiché questa richiede tipologie di calcolo molto diverse tra loro, che vanno dall'alto "*throughput* ", flusso di dati in ingresso e/o in uscita, all'alto numero di "*flops*", operazioni in virgola mobile al secondo. Inoltre, i dati manipolati in tale applicazione hanno un volume molto elevato e sono profondamente eterogenei, sia dal punto di vista dell'archiviazione che dal punto divista della natura del fenomeno che descrivono, e rappresentano un buon paradigma per analizzare l'approccio al big data ed il loro sfruttamento con questa tipologia di calcolo.
Durante il corso si esploreranno i tre cardini del calcolo, rappresentazione, manipolazione e visualizzazione del dato.
La rappresentazione del dato è quella branca delle della scienza dell'informazione, e del corso che si propone, che studia come il dato viene archiviato (formato elettronico) e come viene descritto (metadato associato). Durante il corso verranno esplorati i differenti e più diffusi formati. Verrà esplorato con maggiore dettaglio il formato PDS4, usato in planetologia, al fine di comprendere la filosofia dell'*LTP*, *Long Term Preservation*.
La manipolazione del dato è il ramo in cui si studia il problema che si vuole affrontare e la tipologia dei dati che devono essere utilizzati al fine di determinare l'approccio informatico (sequenziale parallelo, uso GPU etc.) l'algoritmo e linguaggio più idoneo.

Sempre nell'ambito della manipolazione, di particolare interesse è *l'housing* del software, che nel mondo del cloud ha differenti soluzioni, dal *PaaS* (*Plataform as a Service*) al *SaaS* (*Software as a Service*). **La rappresentazione del dato** studia come il dato deve essere rappresentato al fine di essere compreso nella sua interezza e nei sui vari aspetti. La rappresentazione tramite uno schema cartesiano rappresenta solo il caso più semplice di rappresentazione. Nel caso di dato multi-variabile sono estremamente interessanti le rappresentazioni interattive multidimensionali o il *layering*, cioè la sovrapposizione di più tipologie di dato. Di particolare interesse, sia per l'aspetto accattivante che per le possibilità di analisi, sono le nuove tecniche di rappresentazione in realtà aumentata ed in realtà immersiva.
Durante il corso verranno esplorati i fondamenti del **linguaggio Python**, al fine di applicare i concetti discussi a casi studio reali.
Il corso proposto può essere così schematizzato:

1. L'evoluzione del calcolo.
2. Definizione di dato e metadato;
3. Sistemi di archiviazione dei dati e dei metadati;
4. I database relazionali (SQL) e non relazionali (MongoDB);
5. Architettura Cloud;
6. I dati nel Cloud;
7. Il calcolo nel Cloud;
8. Virtualizzazione e Container
9. Microservices e DevOps
10. La visualizzazione del dato.
11. Realtà aumentata e VR.
12. Fondamenti di Python orientato agli oggetti.

B19. Lepton Collider Physics

Dr. TASSIELLI Gianfranco
giovanni.tassielli@le.infn.it

Introduction to the main aspects of particle physics, the Standard Model lagrangian and the main measurements performed at the lepton colliders during the last 70 years.

History and results of some notable lepton colliders as: ADA, ADONE, SPEAR, PEP, PETRA, TRISTAN, LEP, PEP-II and KEK-B.

Future perspectives, FCC-ee and the precision physics.

B20. Particle Physics Laboratory

Dr. TASSIELLI Gianfranco
giovanni.tassielli@le.infn.it

Theory:

Introduction to drift chamber operating principles:gas mixtures properties; drift velocity; gain and Townsend coefficients; signal formation theory and front-end signal; electronics for signal management (shaper circuits and amplification stages).

Practices activity:

- building of: a drift tube; a passive front-end electronics; an active front-end electronics.

- Test, measurement and characterization of the detector performances: efficiency and gas gain.